

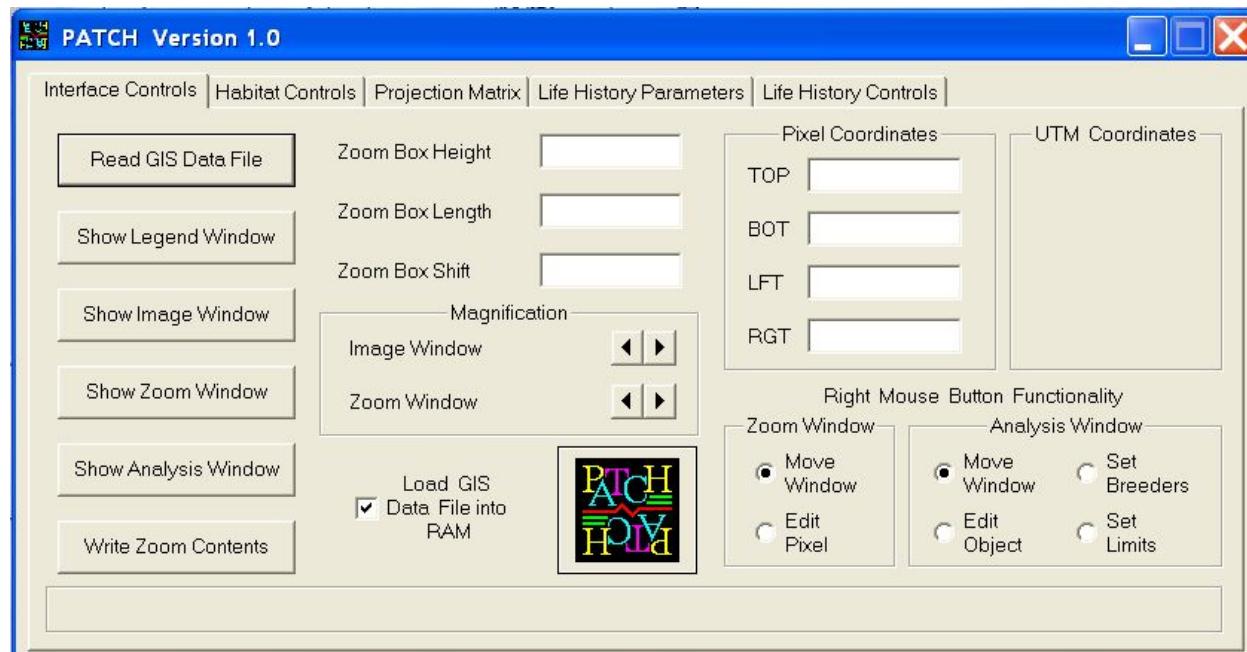
PATCH Example 1

Territory Allocation

Introduction

This example introduces the territory allocation module. It is also intended to help familiarize you with PATCH methods for reading and writing data, and for displaying imagery and modeling results. You will need access to the Clayoquot bitmap and control files distributed with the PATCH model.

The PATCH Control Window is the first window displayed when the model is started. This window has multiple tabular views with buttons and text fields that allow you to access and parameterize the functionality of PATCH. These views are collectively referred to as *control window views*.



The control window views of PATCH are:

- Interface Controls
- Habitat Controls
- Projection Matrix
- Life History Parameters
- Life History Controls

PATCH-generated windows that contain images are referred to as *graphics windows*. The PATCH graphics windows include:

- GIS Image Window
- Legend Window
- Zoom Window
- Analysis Window

Over the course of this example, you will exercise most of the methods accessed through the Interface Controls and Habitat Controls views. You will also display each of the graphics windows of PATCH. If at any time a graphics window displays improperly, for example due to a change in magnification rate, simply double-click once or twice within the window to restore a proper display.

Every window in PATCH has a name, usually displayed in the window header. Footers, located at the bottom of the windows, are often used to display data and error messages generated by PATCH operations. Most control window views and graphics windows display information in footers. As you work through this example, be sure to monitor the information displayed in window footers.

Starting PATCH

Begin by starting the PATCH executable.

- execute PATCH.exe

The window header indicates the version of software being used.

Reading GIS Data

Locate the GIS Data File button and load the Clayoquot habitat data file.

- from the Interface Controls view, click the Read GIS Data File button

- select clayoquot.bmp and click Open
- allow time for these data to be read

If the Clayoquot image has been successfully loaded, the Control Window footer displays the number of rows and columns present in the data. The Clayoquot image contains 3731 rows and 4301 columns. If PATCH has trouble reading the clayoquot data set or its control file, an error messages is written to the window footer.

Displaying GIS Data

- from the Interface Controls view, click the Show Image Window button
- drag the Image Window to a convenient location, revealing the Interface Controls view

The Image Window display is a subsample of the Clayoquot GIS data. When GIS data are read, a subsampling ratio is chosen to guarantee a GIS Image window display no smaller than 100 x 100 pixels; the aspect ratio of the dataset is preserved. Small datasets may be displayed without subsampling. The Image Window header displays the name of the GIS data set being used.



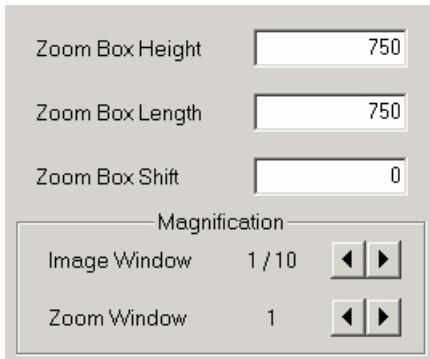
- increase the Image Window Magnification from 1/18 to 1/10 using the increment widget 

Note how this expands the size of the Image Window. Now drag the Image Window to a convenient location on the desktop.



Setting the Zoom-Box Size

- change Zoom Box Height and Zoom Box Length to 750 pixels each



- click on the tab that displays the Habitat Controls view
- click the cyan color cell (CY) to change the color of the zoom box displayed in the Image Window

You can select among eight zoom box color choices to achieve optimal contrast with your GIS data.

Using the Zoom Window

The Zoom Window displays part, or all, of the GIS data. The Zoom Window will subsample the data, depending on window size and magnification. While the Image Window **always** depicts the entire GIS dataset, the Zoom Window allows you to define an area of interest for further operations.

- return to the Interface Controls view and click the Show Zoom Window button
- double-click once in the Zoom Window
- drag the Zoom Window to a convenient location

Pixel Coordinates		UTM Coordinates	
TOP	1490	5469560.00	
BOT	2239	5447060.00	
LFT	1775	283220.00	
RGT	2524	305720.00	

The Zoom Window footer should read *Rows 1490-2239 [] Cols 1775-2524*. If not, directly modify the location of the zoom box by altering the *Pixel Coordinates* fields of the Interface Controls view. These are labeled *TOP*, *BOT*, *LFT*, and *RGT*. Change these fields to 1490, 2239, 1775, and 2524, respectively.

- select a data pixel by clicking and holding the left mouse button anywhere in the Zoom Window
- note data displayed in the Zoom Window footer, then release left mouse button

While the mouse button is down, the selected pixel is highlighted (painted white). The Zoom Window footer concurrently displays the pixel row and column position and indicates which legend category it belongs to.

- minimize the Zoom Window

Setting the Legend Weights

- from the Interface Controls view, click the Show Legend Window button
- in the Legend Window, place the mouse cursor on the category labeled "Old Growth" and left click six times
- note that you can right click on a category to reduce the assigned value
- repeat this processes in succeeding categories until the first six categories in the Legend Window (*Old Growth, Open Canopy Forest, Muskeg Forest, Bonsai Forest, Natural Mature Forest, Natural Deciduous Forest*) have the values 6, 5, 2, 1, 4, 3

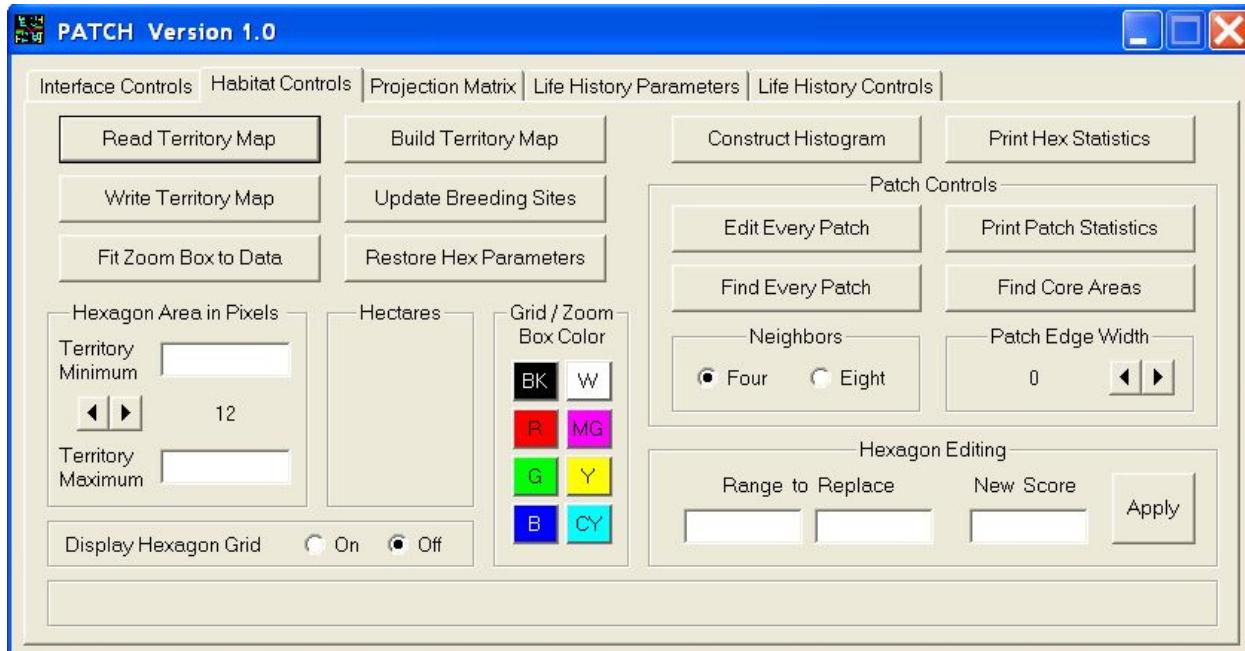


The legend window displays the habitat classes present in the GIS data. The categories displayed were read from the clayoquot.ctrl file in conjunction with input of the GIS image. The first six classes listed in the legend have been assigned nonzero habitat weights. The other categories have weights of zero.

A shift-left click increments a habitat category value by 10. A shift-right click decrements a value by 10. Reducing a value below 0 results in "wraparound" to the value 99. Recovery is simple; give it a try.

Setting the Hexagon Size

- drag the Legend Window to a convenient location, revealing the Control Window
- return to the Interface Controls view and click the Show Zoom Window button
- click on the tab that displays the Habitat Controls view



- set Display Hexagon Grid to On
- the hexagon grid may not yet be visible in the Zoom Window

A hexagon grid can be overlayed on top of the image in the Zoom Window. At current settings, each hexagon is 12 pixels in size (1.08 ha) and may not display at this magnification.

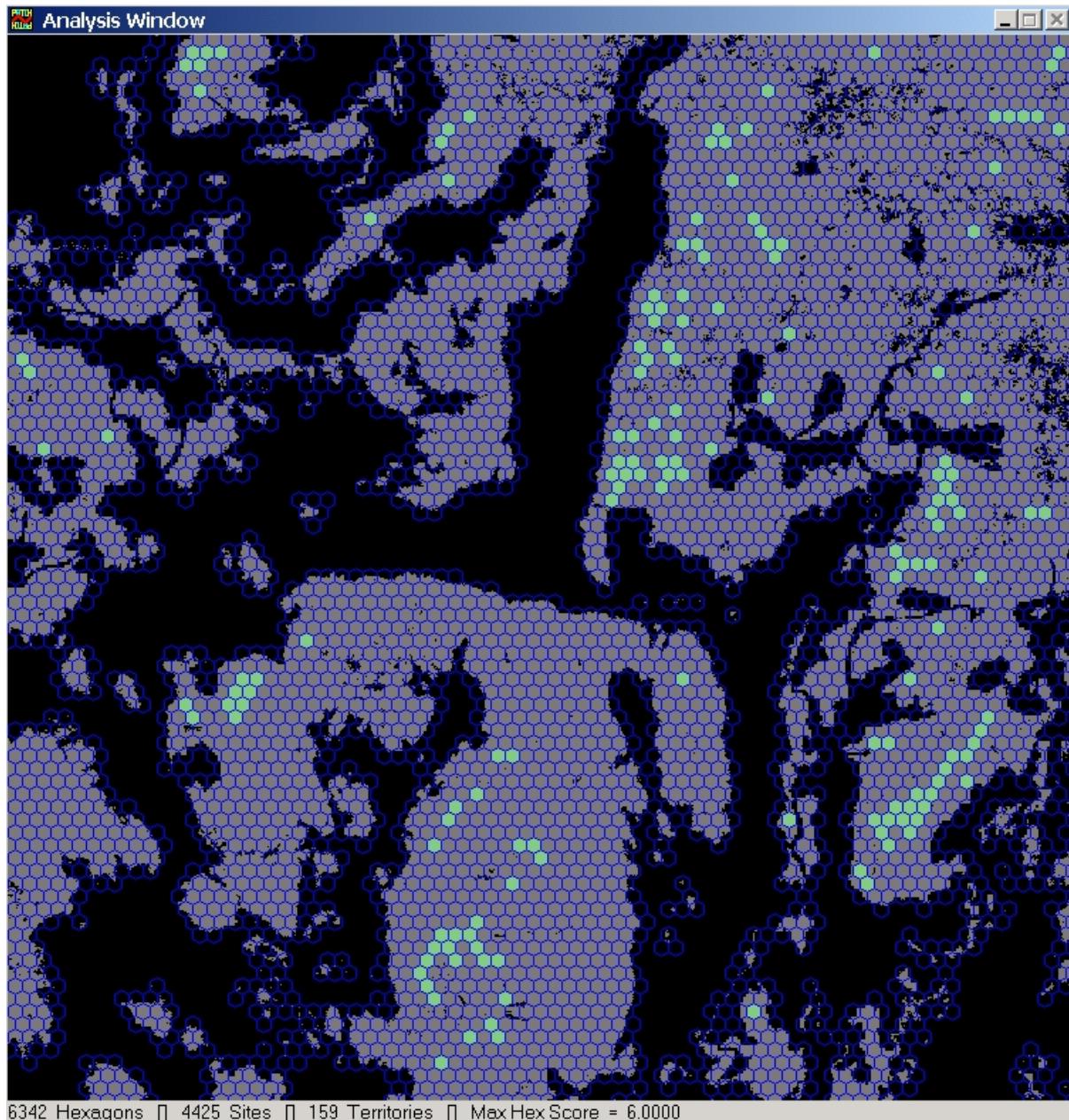
- left click the increment (right) widget in Hexagon Area in Pixels twice, increasing the hexagon size to 90 pixels
- the hexagon grid should be visible in the Zoom Window
- Habitat Controls view declares hexagon area to be 8.10 hectares

Using the decrement and increment widgets , the hexagon area can be varied considerably (e.g., to 10044 pixels or larger). Each time the hexagon area is altered, its new value is automatically assigned to the *Territory Minimum* and *Territory Maximum* fields.

Building a Territory Map

- click the Build Territory Map button
- return to the Interface Controls view and click the Show Analysis Window button
- double-click in the newly displayed Analysis Window
- Analysis Window footer reads "6342 Hexagons," "4425 Sites," "159 Territories"

When you click the *Build Territory Map* button, PATCH constructs a territory map for the zoom window region based on the hexagon size selected and category values assigned in the Legend Window. The result can be displayed in the Analysis Window.



The analysis window footer indicates that the map has a total of 6342 hexagons, that 4425 of them contain at least some significant habitat (these are painted either gray or green), and that 159 of them are potential territories (painted green), which implies that they are suitable for breeding.

Selecting a Hexagon

- select a hexagon by clicking and holding the left mouse button anywhere in the Analysis Window
- the hexagon is highlighted
- note data displayed in the Analysis Window footer: hexagon number (ID), area in pixels, and habitat score

While the left mouse button is held down, a hexagon is highlighted (painted white) in the Analysis Window. The footer displays its ID number, area in pixels, and habitat score. Hexagon ID numbers are assigned sequentially row by row from top to bottom. A hexagon's area is equal to the number of pixels of significant habitat it contains. Habitat values are defined in the Legend Window. Significant habitat categories are assigned nonzero values. A hexagon's habitat score is the mean of the habitat values assigned to the pixels it contains.

- release left mouse button
- return to the Habitat Controls view

The threshold score is the minimum score a hexagon must have to qualify as suitable for breeding. Hexagons can "borrow" habitat from their neighbors in order to attain this threshold value, but the amount that can be lent is limited by the maximum territory size. The threshold score for this territory map is equal to 6.0 (the largest value assigned to a habitat category) because the *Territory Minimum* field is currently set equal to the hexagon area. Territory minimum and maximum will be adjusted in the next exercise.

- note mean step size declared in Habitat Controls view footer

The Habitat Controls view footer displays the mean step size. This is the average center-to-center distance from a hexagon to each of its six neighbors. The step size is reported as a mean value because PATCH raster hexagons are not entirely symmetric. The distances between horizontal and diagonal neighbors differ slightly. Knowing the mean step size is useful when parameterizing the life history simulator. The mean step size is always reported in meters (305.91 meters in this case).

Territory Minimum and Maximum

The *Territory Minimum* and *Territory Maximum* fields control the number of hexagons designated as suitable for breeding. Altering them does not change hexagon habitat scores or hexagon sizes, but does influence available territories.

- under Hexagon Area in Pixels change Territory Minimum to 80; note Territory Minimum is now 7.20 Hectares
- click Update Breeding Sites button
- Analysis Window footer reads "6342 Hexagons," "4425 Sites," "1052 Territories"

This changes the threshold score from 6.00 to 5.33, thus increasing the number of breeding sites present in the landscape from 159 to 1052.

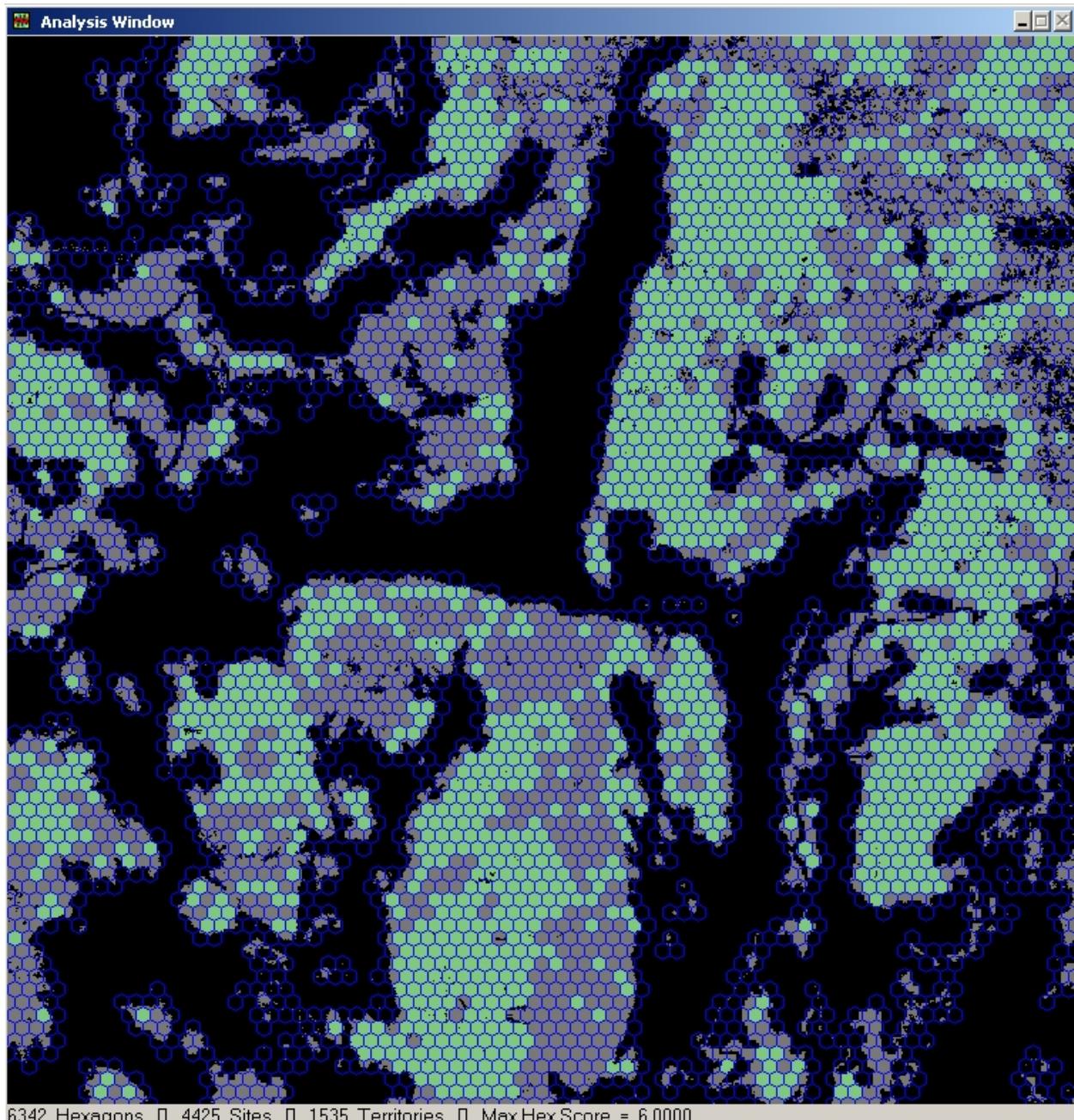
Interface Controls | Habitat Controls | Projection Matrix | Life History

Read Territory Map	Build Territory Map
Write Territory Map	Update Breeding Sites
Fit Zoom Box to Data	Restore Hex Parameters
Hexagon Area in Pixels	
Territory Minimum	80
<input type="button" value="◀"/> <input type="button" value="▶"/>	90
Territory Maximum	100
Hectares	
	7.20
	8.10
	9.00
Grid / Zoom Box Color	
BK	W
R	MG
G	Y
B	CY
Display Hexagon Grid <input checked="" type="radio"/> On <input type="radio"/> Off	
6342 Hexagons	

- under Hexagon Area in Pixels change Territory Maximum to 100; note Territory Maximum is now 9.00 Hectares
- click Update Breeding Sites button

This further increases the number of breeding sites present in the landscape from 1052 to 1535. You probably noticed the change of breeding site distribution in the Analysis Window.

- Analysis Window footer reads "6342 Hexagons," "4425 Sites," "1535 Territories"



Saving the Results

PATCH can save the results of the territory allocation process.

- click Write Territory Map
- enter a filename for output (e.g. exam1) and click Open
- PATCH generates a binary output file (e.g. exam1.hxgn)

Locating Core Habitat Areas

- under Patch Controls, set Patch Edge Width to 10
- under Patch Controls, click the Find Core Areas button; core habitat, painted cyan, appears in the Analysis Window

A limited quantity of core habitat is visible in the analysis window. The process of locating core habitat in patch (described in PATCH Example 3) and territory maps is the same, and the presence of the hexagon boundaries does not affect the results. Core habitat identified during territory allocation is always represented by cyan.

- under Patch Controls, set Patch Edge Width to 0

Setting the edge width to zero prevents PATCH from locating core areas and consequently speeds up subsequent analyses.

Hexagon Statistics

- click the Build Territory Map button, removing the display of core areas
- click the Print Hex Statistics button
- enter an output filename for the hexagon statistics file, then click Open
- inspect content of hexagon statistics file using any text browser (e.g. WordPad)

This statistics file begins with a header that identifies the GIS data set being used. The rows and columns corresponding to the boundaries of the zoom box are also specified. Further data specify hexagon area and territory size values. Total number of hexagons and the distance between hexagon centers are also listed. The header ends with a description of the legend values you set. The remainder of the file is a table listing attributes of every hexagon present in the landscape. Several lines of these data are shown below.

```

# Input File Name Used : X:\Projects\PATCH\examples\data\clayoquot
# Analysis Is For Rows : 1490 - 2239
# Analysis Is For Cols : 1775 - 2524
# Number Of Hexagons In Zoom Window: 6342
# Distance Between Hexagons (meters): 305.91

# Minimum Territory Size (Pixels) : 80
# Hexagon Area (Pixels) : 90
# Maximum Territory Size (Pixels) : 100

# Legend Value, Weight : 0, 6, Old Growth
# Legend Value, Weight : 1, 5, Open Canopy Forest
# Legend Value, Weight : 2, 2, Muskeg Forest
# Legend Value, Weight : 3, 1, Bonsai Forest
# Legend Value, Weight : 4, 4, Natural Mature Forest
# Legend Value, Weight : 5, 3, Natural Deciduous Forest

+=====+
| Hexagon   Year-Zero    Lambda   Breed   Number   Number   Movements   Movements   Breeding   |
| Index     Score        Value    In Hex   Births   Deaths   Into Site  Out of Site  Events    |
+=====+
   11      0.1333    0.0000    NO       0        0        0          0          0          0
   12      0.0000    0.0000    NO       0        0        0          0          0          0
   13      2.4667    0.0000    NO       0        0        0          0          0          0
   14      4.8778    0.0000    YES      0        0        0          0          0          0
   15      4.9333    0.0000    YES      0        0        0          0          0          0
   16      4.9111    0.0000    YES      0        0        0          0          0          0
   17      4.9111    0.0000    YES      0        0        0          0          0          0
   18      3.6111    0.0000    NO       0        0        0          0          0          0
   19      0.9778    0.0000    NO       0        0        0          0          0          0
   20      0.0000    0.0000    NO       0        0        0          0          0          0
.
.
```

The table above actually begins with hexagon number 1 (not 11), and ends with hexagon 6342. Scores of hexagons devoid of significant habitat always are zero. Hexagons with habitat scores less than the threshold value do not qualify as breeding sites. Values in other columns are zero pending generation of simulation results.

Hexagon Grid Alignment

- from the Interface Controls view, change Zoom Box Height and Zoom Box Length to 50 pixels each
- increase the Zoom Window Magnification to 10
- click the left mouse button in the Image Window a short distance outside the Zoom Box; the Zoom Box is relocated
- when the box is moved, the Zoom Window and Analysis Window are erased

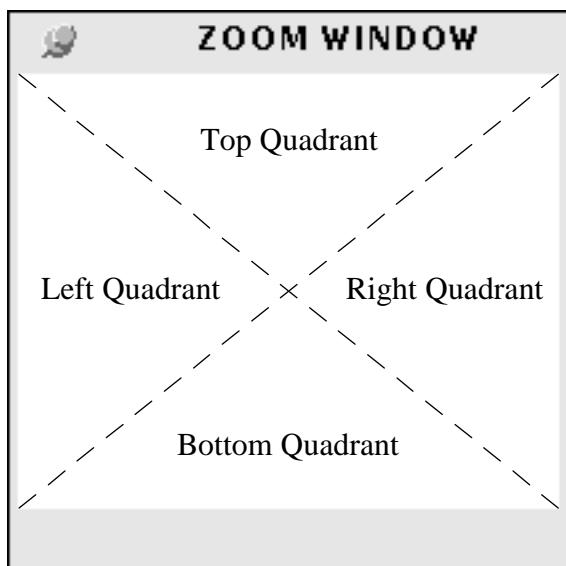
Remember that you can restore displays of the Zoom Window or Analysis Window with one or two double left-clicks of your mouse. However, if the Zoom Box is outside of the 750 x 750 pixel area where the territory build was conducted, the Analysis Window display will be empty.

- from the Interface Controls view, reset the Zoom Window Magnification to 1
- click on the tab that displays the Habitat Controls view
- to return the Zoom Window to its location at the last Build Territory event, click the Fit Zoom Box to Data button
- if necessary, left double-click once or twice in the Zoom Window to restore its display
- if necessary, left double-click once or twice in the Analysis Window to restore its display
- the Zoom Window footer should read "Rows: 1490 - 2239" and "Columns: 1775 - 2524"

- set Display Hexagon Grid to Off; note change in Zoom Window display
- set Display Hexagon Grid to On

Moving the Zoom Box

As shown in the last exercise, the zoom box location can be manipulated in the Image Window. You can also change the zoom box location through right mouse click actions in the Zoom Window with the *Move Window* mode. The Zoom Window will be repainted each time the zoom box moves (if the Zoom Window is correctly sized; double-click the Zoom Window with the left mouse button whenever resizing is needed).



Imagine dividing the zoom window into quadrants by connecting its opposite corners with two diagonal lines. This defines four triangular regions that are the *top*, *bottom*, *left*, and *right* quadrants. When the right mouse button is clicked in one of these quadrants (with *Move Window* mode set), the zoom box moves incrementally in the Image Window. The increment size is specified in pixels, and is set in the *Zoom Box Shift* field. If the *Zoom Box Shift* field is set to zero, however, the increment size equals either the height or width of the zoom-box.

Right Mouse Button Functionality			
Zoom Window		Analysis Window	
<input checked="" type="radio"/> Move Window	<input type="radio"/> Move Window	<input type="radio"/> Set Breeders	
<input type="radio"/> Edit Pixel	<input type="radio"/> Edit Object	<input type="radio"/> Set Limits	

- in the Interface Controls view, set Right Mouse Button Functionality for the Zoom Window to Move Window
- change Zoom Box Height and Zoom Box Length to 200 pixels each
- from the Interface Controls view, reset the Zoom Window Magnification to 2
- left double-click twice in the Zoom Window to resize its display; ignore the Analysis Window for now
- move the mouse cursor to the Zoom Window's top quadrant
- slowly click the **right** mouse button three times, observing the movement of the Zoom Box in the Image Window

Because the *Zoom Box Shift* field is set to zero, each click moves the zoom box 200 pixels northward, a distance equal to its height.

- move the mouse cursor to the Zoom Window's left quadrant
- slowly click the **right** mouse button three times, observing the movement of the Zoom Box in the Image Window

This moves the zoom box a distance of 600 pixels (three times the zoom box width) to the west.

- change the Zoom Box Shift value to 10
- move the mouse cursor to the Zoom Window's left quadrant
- click the **right** mouse button once, observing the movement of the Zoom Box in the Image Window
- move the mouse cursor to the Zoom Window's bottom quadrant
- click the **right** mouse button twice, observing the movement of the Zoom Box in the Image Window
- Zoom Window footer should read "Rows: 1185 - 1384" and "Columns: 1440 - 1639"



A small island should be visible in the upper half of the zoom window. The zoom window footer should read *Rows 1185-1384 [] Cols 1440-1639*.

Pixel Coordinates		UTM Coordinates
TOP	1185	5478710.00
BOT	1384	5472710.00
LFT	1440	273170.00
RGT	1639	279170.00

Editing Hexagon Scores by Range

- from the Interface Controls view, reset the Zoom Window Magnification to 1
- return to the Habitat Controls view
- click Read Territory Map button
- open the previously written territory map (e.g. exam1.hxgn) for input
- click the Fit Zoom Box to Data button--the Zoom Box region now conforms to the input data
- to update the Zoom Window, double-click the window twice with the left mouse button
- to update the Analysis Window, double-click the window with the left mouse button
- arrange the windows so that the Habitat Controls view is visible, as well as the Analysis Window

The Hexagon Editing box is found in the lower right corner of the Habitat Controls view. Locate the two numeric fields in the Hexagon Editing box labeled *Range to Replace*. These fields are used to set a range of habitat scores defining a target set of hexagons whose habitat scores will be altered as a group.

Hexagon Editing			
Range to Replace	New Score	Apply	
<input type="text" value="0"/>	<input type="text" value="5.99"/>	<input type="text" value="0.0"/>	<input type="button" value="Apply"/>

- under Hexagon Editing, in the Range to Replace boxes, set the left box to 0 and the right box to 5.9999
- under Hexagon Editing, set New Score to 0.0
- under Hexagon Editing, click the Apply button
- allow time for the Analysis Window to update

PATCH identifies every hexagon lying entirely within the zoom box (all of the hexagons in this case) that has a score greater than or equal to zero, but less than six. The model then changes the scores of these hexagons to zero.

Note those hexagons prominently displayed in the Analysis Window. These hexagons originally had (and still have) a score of exactly six. Only hexagons having a score less than six were modified in the preceding step. (None of the hexagons in the territory map currently has a score greater than six because six was the highest value assigned to a habitat category in the Legend Window.) Select a few of these hexagons to confirm that they really do have a score of six.

Examine some other hexagons as well. They should all have scores of zero.

- click the left mouse button on highlighted hexagons to confirm they have a score of 6.0 (read footer)
- click the left mouse button on other hexagons to confirm they have a score of 0.0 (read footer)

Notice that hexagons containing habitat are never painted black, even after their scores have been changed to zero.

This territory map has the same spatial distribution of breeding sites as was present in the original map, when the territory minimum and maximum were equal to the hexagon size. In both cases, only hexagons with scores of exactly six qualified as breeding sites. Now increase the upper end of the range of target hexagon scores to seven and reset habitat scores in this range to zero.

- under Hexagon Editing, in the Range to Replace boxes, set the left box to 0 and the right box to 7.0
- under Hexagon Editing, leave the New Score set to 0.0
- under Hexagon Editing, click the Apply button
- allow time for the Analysis Window to update

The territory map should no longer contain any sites suitable for breeding.

Editing Hexagon Scores by Hand

- under Hexagon Editing, set New Score to 5.334
- click on the tab that displays the Interface Controls view
- under Right Mouse Button Functionality, set the Analysis Window mode to Edit Object
- in the Analysis Window, click the **right** mouse button on any gray hexagon; the hexagon turns blue
- repeat this for a second hexagon; the second hexagon turns blue, while the first displays as dull green
- note: a hexagon is not displayed in dull green if assigned score is less than threshold score
- note: the habitat sharing algorithm is applied in response to *each* hexagon value assignment

Click left on any gray hexagon. The hexagon turns blue, indicating its habitat score has been modified. The scores of hexagons that do not contain any habitat (those painted black) can not be changed with this routine, nor by using the Hexagon Editing functionality previously described.

The habitat sharing algorithm is applied in response to *each* hexagon value assignment. The only breeding sites present in this modified landscape are the sites you have altered using *Edit Object* mode in the Analysis Window. No other hexagons can achieve breeding status by borrowing habitat, since the *New Score* field is set right at 5.334, the current threshold score.